

OAuch

Automatically Analyzing the Security of an OAuth 2.0 Implementation

Pieter Philippaerts



Exploring OAuth 2.0

A practical guide to securing your APIs

Peter Philippaerts



<https://www.apisec.be/media>



“Once you have implemented OAuth2, how do you know you have implemented it securely?”

SSL Server Test: www.google.com

https://www.ssllabs.com/ssltest/analyze.html?d=www.google.com&s=172.217.6.68&hideResults=1

Qualys SSL Labs

Home Projects Qualys Free Trial Contact

You are here: Home > Projects > SSL Server Test > www.google.com > 172.217.6.68

SSL Report: www.google.com (172.217.6.68)

Assessed on: Mon, 20 Jul 2020 06:35:49 UTC | HIDDEN | [Clear cache](#)

[Scan Another »](#)

Summary

Overall Rating

B

	Certificate	Protocol Support	Key Exchange	Cipher Strength
Certificate	100	100	100	100
Protocol Support	100	100	100	100
Key Exchange	100	100	100	100
Cipher Strength	100	100	100	100

Visit our [documentation page](#) for more information, configuration guides, and books. Known issues are documented [here](#).

This server supports TLS 1.0 and TLS 1.1. Grade capped to B. [MORE INFO »](#)

This server supports TLS 1.3.

Static Public Key Pinning observed for this server.

HTTP Strict Transport Security (HSTS) with long duration deployed on this server. [MORE INFO »](#)

DNS Certification Authority Authorization (CAA) Policy found for this domain. [MORE INFO »](#)

Scan results for www.facebook.com

https://securityheaders.com/?q=www.facebook.com&follo...

Security Headers

Sponsored by Report URI

Scan your site now

www.facebook.com

Hide results Follow redirects

Scan Results

Security Report Summary

	Site: https://www.facebook.com/
	IP Address: 2a03:2880:f131:83:face:b00c:0:25de
	Report Time: 20 Jul 2020 10:51:59 UTC
Headers:	✓ Strict-Transport-Security ✓ Content-Security-Policy ✓ X-Content-Type-Options ✓ X-Frame-Options ✗ Referrer-Policy ✗ Feature-Policy
Warning:	Grade capped at A, please see warnings below.

Supported By

Report URI

Site results - OAuch

https://oauch.io/Dashboard/Results/9aaef59f-5cb5-4a...

DnetBox - Home DnetShare DistriNet Code KU Leuven Webmail Cybersecurity Prog...

Dashboard Tests overview FAQ About OAuch Sign out

Site results

You are here: Home / SSL Report / Assessed on: Monday, July 20, 2020 at 10:51:59 UTC

There are 1 pending test(s) that have not been (fully) executed yet. Hence, the results presented here are incomplete. To complete the results, please [resume the test run](#).

The site was successfully tested on February 1, 2021 at 16:44. The details of this test run can be found below. To test the site again, [click here to start a new test run](#).

Results Failed tests All tests Threats Full log Reporting History

Threats

- Mitigated threats: 16
- Partially mitigated threats: 7
- Unmitigated threats: 6

Deprecated features

- Deprecated features detected: 2

Countermeasures

- Mandatory test cases failed: 7 (15.9 %)
- Recommended test cases failed: 0 (0.0 %)



Summary

Address: https://www.facebook.com/
Address: 2a03:2880:f131:83::face:b00c:0:25de
Report Time: 20 Jul 2020 10:51:59 UTC

Headers:

- Strict-Transport-Security
- Content-Security-Policy
- X-Content-Type-Options
- X-Frame-Options
- Feature-Policy

Warning: Grade capped at A, please see warnings below.

The OAuch Tool

Internet Engineering Task Force (IETF)
Request for Comments: 6749
Obsoletes: 5849
Category: Standards Track
ISSN: 2070-1721

D. Hardt, Ed.
Microsoft
October 2012

The OAuth 2.0 Authorization Framework

Abstract

The OAuth 2.0 authorization framework enables a third-party application to obtain limited access to an HTTP service, either on behalf of a resource owner by orchestrating an approval interaction between the resource owner and the HTTP service, or by allowing the third-party application to obtain access on its own behalf. This specification replaces and obsoletes the OAuth 1.0 protocol described in RFC 5849.

Status of This Memo

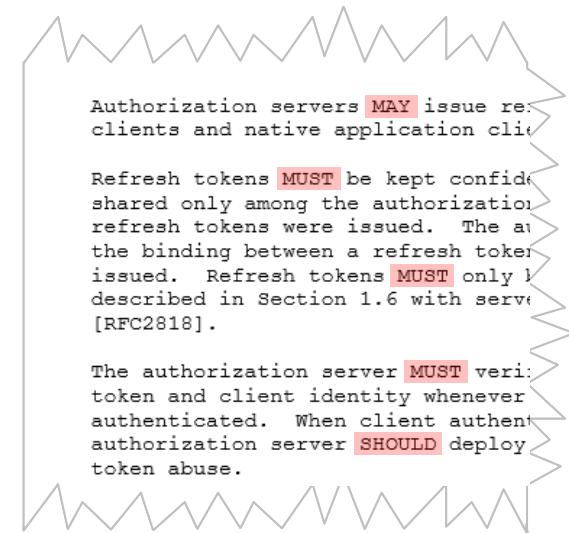
This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 5741.

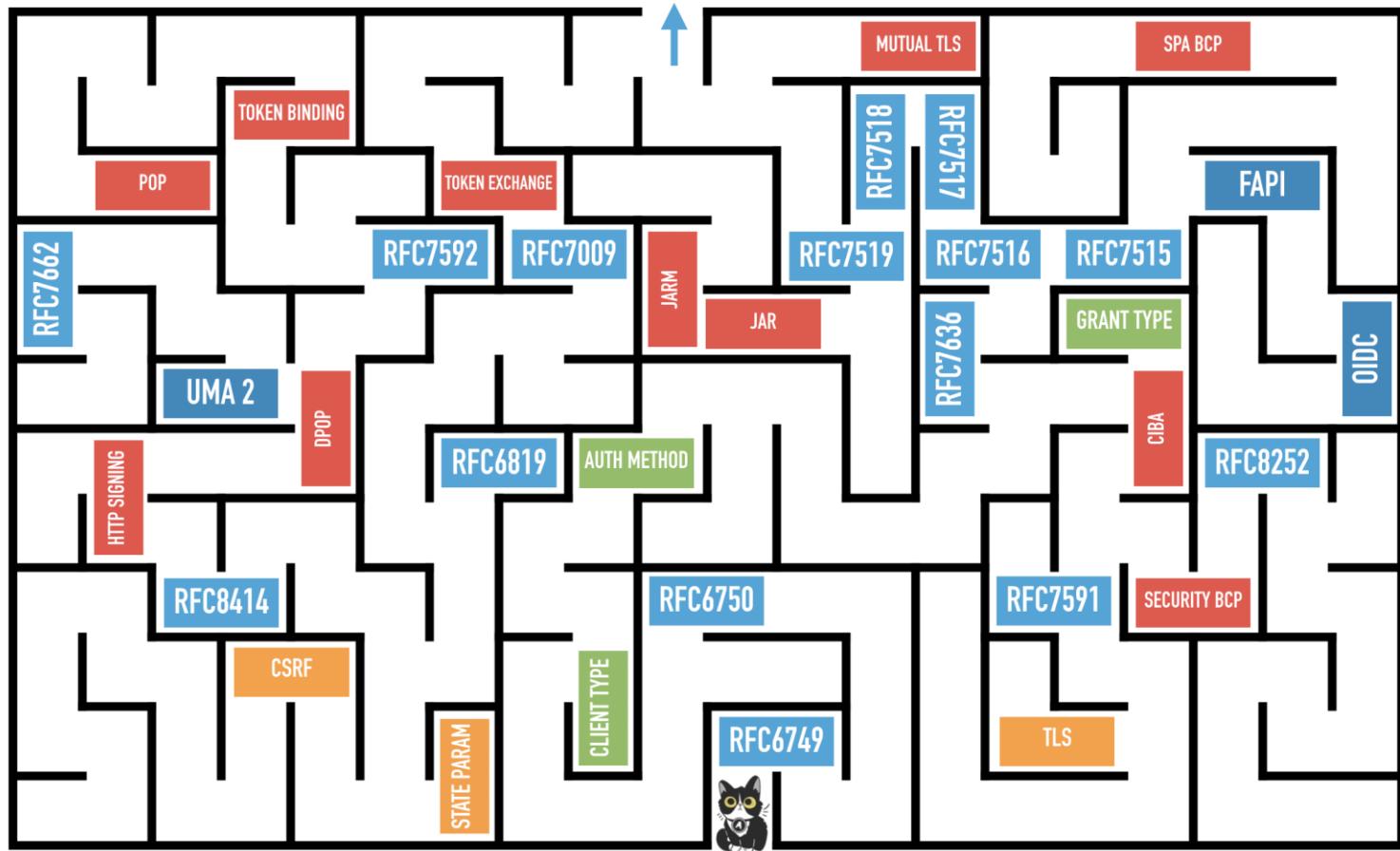
Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at <http://www.rfc-editor.org/info/rfc6749>.

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BUILDING YOUR APPLICATION



Building a test case

The client MUST NOT use the authorization code more than once.

- » OAuch tries to use the same authorization code two times and keeps track of the server's response

Test case coverage

- › OAuch implements 112 unique test cases from 10 documents
 - » Many documents contain the same requirements
 - » If a requirement has varying requirement levels, OAuch picks the strictest one
- › Not all security requirements can be converted to test cases

Testing Process

- › OAuch is set up like any other client
 - » ... but acts like a malicious client!
- › Access token validation requires an API endpoint
 - » **HTTP 2xx** → access token is valid
 - » **HTTP 4xx/5xx** → access token is invalid

Testing Process

- › OAuch detects which features are enabled on the server
 - » The relevant test cases are selected and run
 - » OAuch keeps a detailed log, that can be inspected by the user
- › Result: a full overview of which countermeasures are enabled on the server
 - » But what does that mean?

OAuth Threat Model

Internet Engineering Task Force (IETF)
Request for Comments: 6819
Category: Informational
ISSN: 2070-1721

T. Lodderstedt, Ed.
Deutsche Telekom AG
M. McGloin

Name →

4.4.2.2. Threat: Access Token Leak in Browser History

Description →

An attacker could obtain the token from the browser's history. Note that this means the attacker needs access to the particular device.

List of counter-measures →

This document does not publish security countermeasures.

This document does not publish security countermeasures.

Countermeasures:

- Use short expiry time for tokens (see Section 5.1.5.3). Reduced scope of the token may reduce the impact of that attack (see Section 5.1.5.1).
- Make responses non-cacheable.

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OAuth Threat Model

- › OAuch integrates this threat model (+BCP) into the analysis
 - » 36 server-side threats are evaluated
 - » A threat can be full mitigated, partially mitigate or not mitigated
- › OAuch gives clear advice to a site owner
 - » Which threats is your site vulnerable to?
 - » Which countermeasures must be implemented to mitigate them?

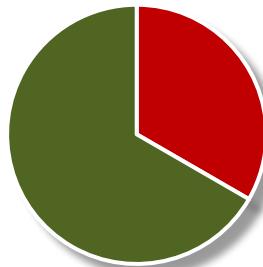
DEMO: OAuch

Analyzing the OAuth 2.0 Ecosystem

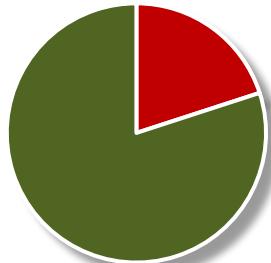
What we did

- › We tested 100 OAuth implementations
 - » 80 API providers, 20 OIDC providers
 - » 75 sites from Top 10000
 - » All publicly available (so they *should* be secure)
- › We drew statistics over the sites and over the individual countermeasures/threats

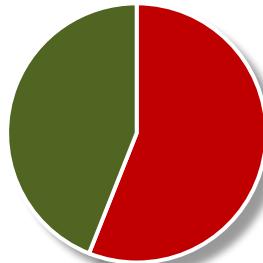
Results – Failure Rates



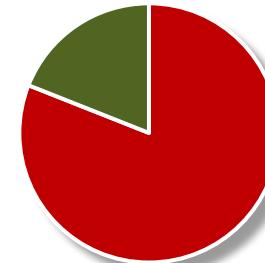
Overall: **33% FR**



Must: **20% FR**

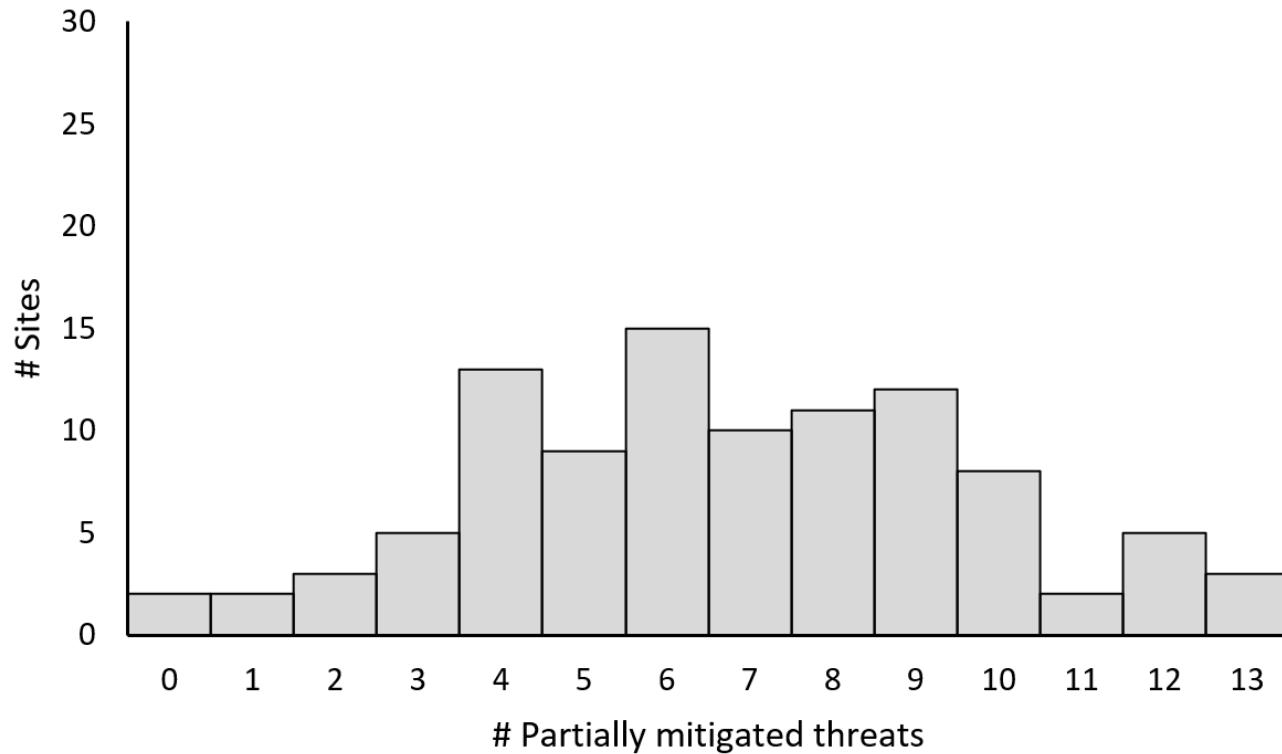


Should: **56% FR**

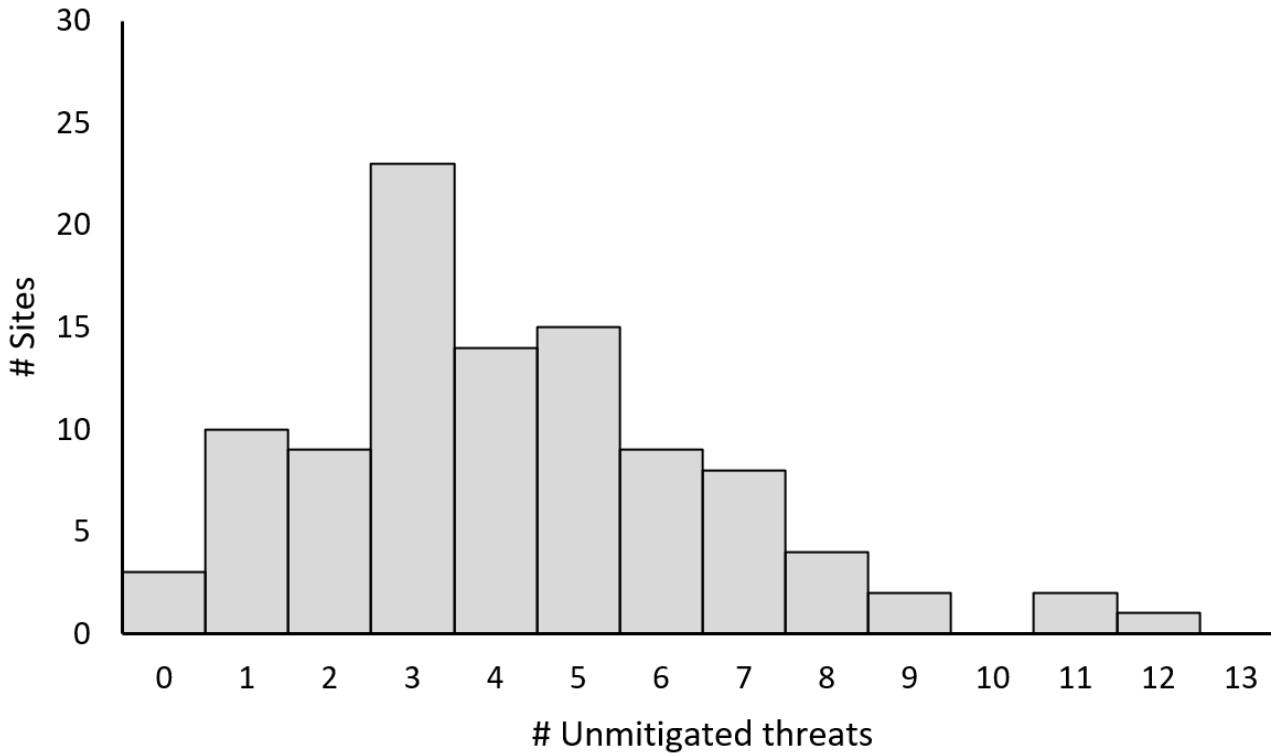


Overall: **81% FR**

Results – Partially Mitigated Threats



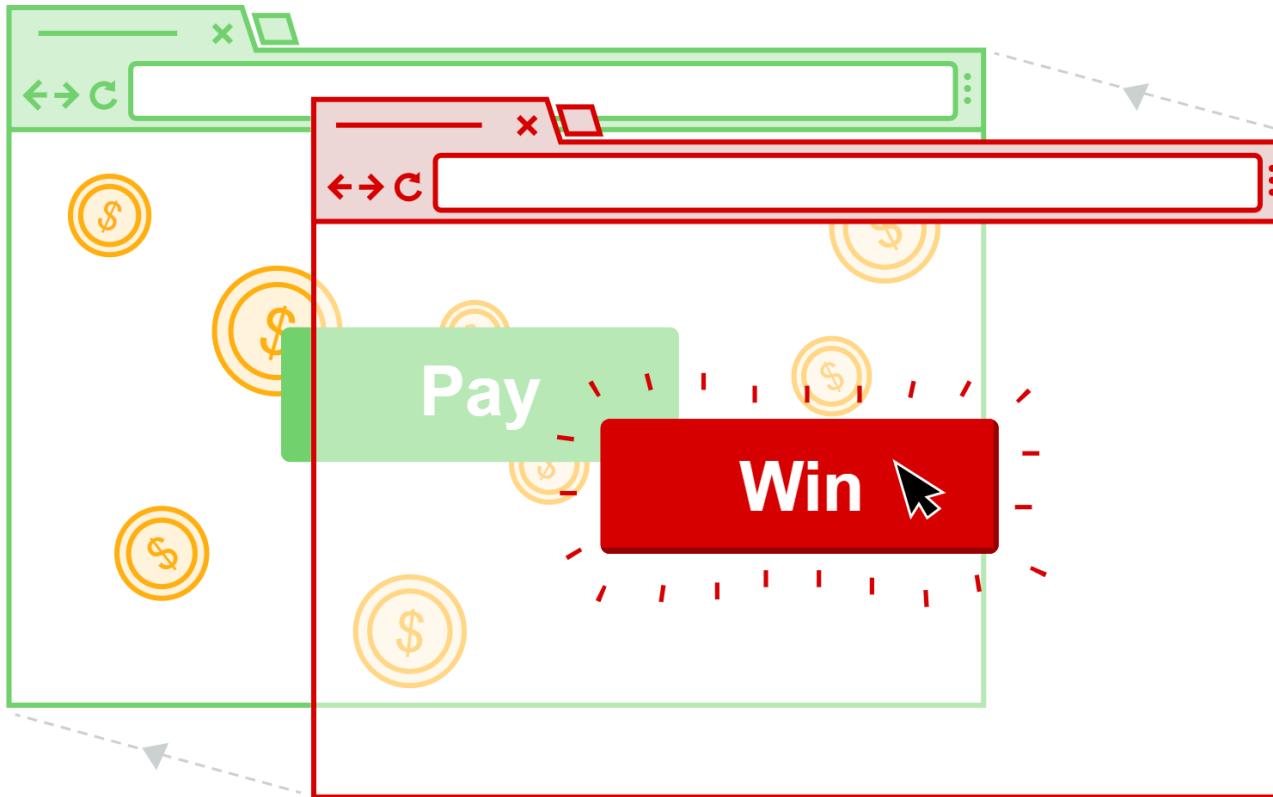
Results – Unmitigated Threats



Confirming the Results

- › To validate the results, we used OAuch as an offensive tool
 - 1. Choose an attack vector
 - 2. Use OAuch to list all vulnerable sites
 - 3. Try to write a proof-of-concept exploit

Confirming the Results – Clickjacking Attack



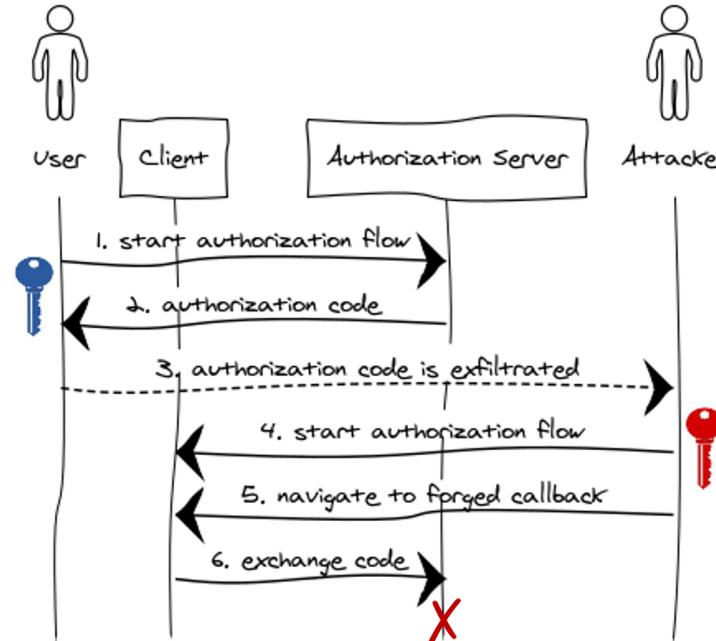
Confirming the Results – Clickjacking Attack

- › OAuch identified 22 sites that could be vulnerable to this threat
 - » After manual verification, 19 could be exploited (86% success rate)
 - » 2 sites used JavaScript to redirect to a secure page
 - » 1 site used frame-busting JavaScript

Confirming the Results – Authorization Code Injection



Threat: Authorization Code Injection



Confirming the Results – Authorization Code Injection

- › Focus on the OIDC providers
 - » Found clients for 12 OIDC providers
 - » These clients were tested for this vulnerability
 - »» Most clients were vulnerable
 - »» For each provider, at least one vulnerable client was found (100% success rate)

“Is it really that bad?”

Is it really that bad?

- › Yes and no.
 - » Yes, the servers do not (fully) mitigate certain threats
 - » No, the threat model assumes a powerful attacker
 - »» Often complex exploitability
 - » No, OAuch assumes no client mitigations

“Why are OAuth implementations lacking so many counter-measures?”

Why are implementations non-compliant?

- › The provider knows about it, but...
 - » ... wants to maintain backward compatibility
 - » ... some countermeasures cannot be efficiently implemented
 - » ... they have other development priorities
 - » ... doesn't care, because “it can be mitigated on the client side”

Why are implementations non-compliant?

- › The provider may not know about it, because...
 - » ... the original OAuth standard is outdated
 - » ... they make invalid assumptions
 - » ... they assume the OAuth library handles everything
 - » ... OAuth looks deceptively easy to implement

Concluding Thoughts

Lessons Learned?

- › It's hard to use these results to create generally applicable advice
 - » Everyone makes different mistakes
 - » OAuch gives tailor-made advice per site

Lessons Learned

- › Do not assume that a library is safe. **Verify that it is.**
- › Update your packages regularly. **Security protocols evolve.**
- › Do not rely on clients making great security decisions.
Enforce them.

Try it!

- › The tool is available on <https://oauch.io/>
 - » Let us know if we can improve something

Conclusions

- › Having a formal verification of the OAuth2 protocol is great
 - » ... but we also need tools to verify practical implementations
- › A lot of sites can benefit from implementing missing countermeasures



Thank you!

<https://distrinet.cs.kuleuven.be/>

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